18 May 1990

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Dear Mr. Truskowski:

This letter discusses the merits of a groundwater remediation alternative involving groundwater withdrawal using wells at the Arkwood Inc. site in Omaha, Arkansas.

INTRODUCTION
It is our opinion that groundwater remediation by pumping in karstic terrains is generally not an appropriate remedial technique. This is an opinion that is generally shared by the most respected practitioners in the field of karst hydrogeology and is consistent with EPA guidance (Refs. 1,2). The major reason that this alternative is not viewed as practicable is that it is generally impracticable, if not impossible, to define karst hydrology through information from wells. Without this definition it is impossible to evaluate the effects of remediation on the affected groundwater.

SETTING
The Arkwood site is located in northwestern Arkansas, in an area underlain by thick sequences of sedimentary rocks, many of which are carbonates. At the site, the surface unit is the Boone limestone, a cherty limestone that is highly susceptible to solution activity. Groundwater beneath the site resides in the cherty clay residuum and in the highly solutioned zone at the surface of the bedrock (the epikarst zone). The boundary between the residuum and epikarst zones is gradational from cherty clay to limestone with air, clay and water-filled conduits and voids.

The deeper groundwater (used as domestic water supplies) occurs at several hundred feet. It is apparently not in communication with the upper water-bearing zones in the vicinity of the site.

Eleven monitoring wells have been drilled on and immediately adjacent to the site.

Five of these wells encountered contaminated groundwater in the residuum/epikarst zone. A summary of the well completion and groundwater data from the eleven wells is presented on Table 1. The total estimated flow from the five contaminated wells is 5 gpm. The weighted average concentration of PCP from the wells is 23 mg/l.

New Cricket Spring is the only confirmed location of contamination in off-site wells or springs. The baseline flow from New Cricket Spring is 15 gpm at a PCP concentration from 1 to 2 mg/l.

ALTERNATIVE UNDER CONSIDERATION

The remedial alternative that is discussed here is one that involves extraction and treatment of groundwater from the five contaminated wells on site along with water that is discharged at the spring. Combining the water from the wells and the spring will result in an estimated base flow through the treatment plant of 20 gpm with a 7 mg/l PCP concentration.

DISCUSSION

The karst in the vicinity of the site is apparently in a mature stage of development. That is, groundwater flow is dominantly through conduits in the epikarst zone. The flow system is analogous to flow through an intricate system of pipes. Since the system is hidden, the conduit locations and the conditions of flow through them is understood largely by inference. What can be said in the case of the site is that the only place that has been confirmed to represent a discharge of contamination off site is New Cricket Spring. How it gets from the site to the spring is and will remain largely a matter of conjecture.

Contrary to granular aquifers, where contamination tends to spread out as it migrates away from the site, contamination tends to flow to a point of discharge in a karst environment. It is therefore consistent with the behavior of this type of environment that all of the contaminated groundwater from the site could discharge at the spring. This means that the spring is an appropriate location to collect contaminated groundwater for treatment.

The characteristics that are described above are the reasons that it is not generally appropriate to pump and treat groundwater from wells in a karst environment with the intention of remediation. While contaminated water may be encountered in wells, their relationship to the hydrogeologic system can generally not be determined without extensive dye tracing studies. Without physical it is generally more cost effective to treat contaminated groundwater at the point(s) of natural discharge.

There are two detrimental affects that this alternative could have by altering flow paths in an unpredictable manner. Collapse and conduit blockage could result from long-term pumping from the five wells. This could cause contaminated groundwater to flow to previously clean springs or wells in the area. The potential for this happening is real but not quantifiable. The second effect is that pumping from the wells may stop flow in a part of the contaminated system. After a period of time this could result in contaminants not flowing to either the spring or the wells, giving the appearance that the groundwater had been remediated. After the wells are turned off, the system could equilibrate and the spring discharge be contaminated again.

There are potentially two positive aspects of treating groundwater at the five affected wells. By removing contaminants at these locations, contaminants that would never reach the spring might be removed. Additionally, the redmediation time could be shortened by a more rapid rate of contaminant removal. It is not practicable to evaluate the possibility of either of these happening, nor is it likely to be able to quantify the degree to which either is occurring during remediation.

CONCLUSION
Implementation of this alternative may result in a more rapid andy more complete cleanup of affected groundwaters but the possibilities of this are not definable. In light of the added costs and the potential of detrimental affects on the system, this may not be a viable alternative for groundwater remediation.

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If you have any questions about this or would like to discuss it further please call me at (713) 621-1620.

Very truly yours,

ROY F. WESTON, INC.

Dan N. MacLemore III, CPGS
Site Manager

DNM/bf

References

1 - "Ground-Water Monitoring in Karst Tenames: Recommended Protocols and Implicit Assumptions," Quinlin, J.F., USEPA 600/x-89/050, Feb, 1989.

2 - "Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites," USEPA/54/G-88/003, OSWER Directive 9283.1-2, Dec. 1988.

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TABLE 1

WELL NO.	SCREENED ELEVATION/ DEPTH (FT.)	SCREENED MATERIAL	APPROXIMATE RECHARGE RATE	PCP LEVELS MG/L	LOCATION SITE/RR
1	1164 - 1144 24.5 - 44.5	Residual	< 1 gpm	2.3-5.7	S
2	1162 - 1136 26-54	LS	<< 1 gpm	< 1	S
3	1154-1134 30-50	LS w/CL	2-3 gpm	< 1	S
4	1156-1146 8-18	LS/CL	< 1 gpm	1.4-7.9	RR
5	1156-1141 8-23	CL	2-3 gpm	12-25	RR
6	1130-1081 63-112	DOL	Dry		S
7	1163-1138 27-66	LS	< 1 gpm	7.8	S
8	1152-1142 9-20	LS/CL	< 1 gpm	< 1	RR
9	1154-1144 5-15	LS/CL	2-3 gpm	ND	RR
10	1154-1143 8-19	CL/LS	< 1 gpm	9-55	RR
11	1148-1138 12-22	LS	<< 1 gpm		RR

LS = Limestone
CL = Clay
DOL = Dolomite
RR – Railroad Right of Way
S = Site Area

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